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HIGHWAY RESEARCH REPORT

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RAVEL AND ROCKFALL PREVENTION

FINAL REPORT

September, 1973

STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

TRANSPORTATION LABORATORY

RESEARCH REPORT

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| 16. ABSTRACT This study was made to determine if ravelling and rockfall could be prevented with spray-on erosion control agents. Two agents were tested: Soil-Lok and Soil-Bond. Both were successful at the applied rates of: Soil-Lok at (4270 gals. of chemicals)/A and Soil-Bond at (350 gals. of concentrate)/A. The Soil-Bond application is more economical. These findings were arrived at by applying both products to two slopes and comparing the resultant rockfall and ravelling with that prior to treatment. | | | | | |
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DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

TRANSPORTATION LABORATORY

5900 FOLSOM BLVD., SACRAMENTO 95819



Trans Lab No. 641139A

September 1973

Mr. J. L. Beaton
Laboratory Director

Dear Sir:

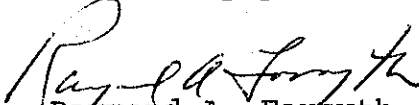
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RAVEL AND ROCKFALL PREVENTION

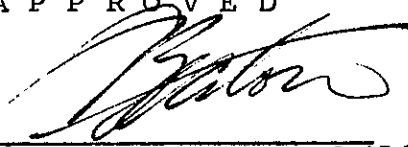
Ronald Mearns and Thomas Hoover
Co-Investigators

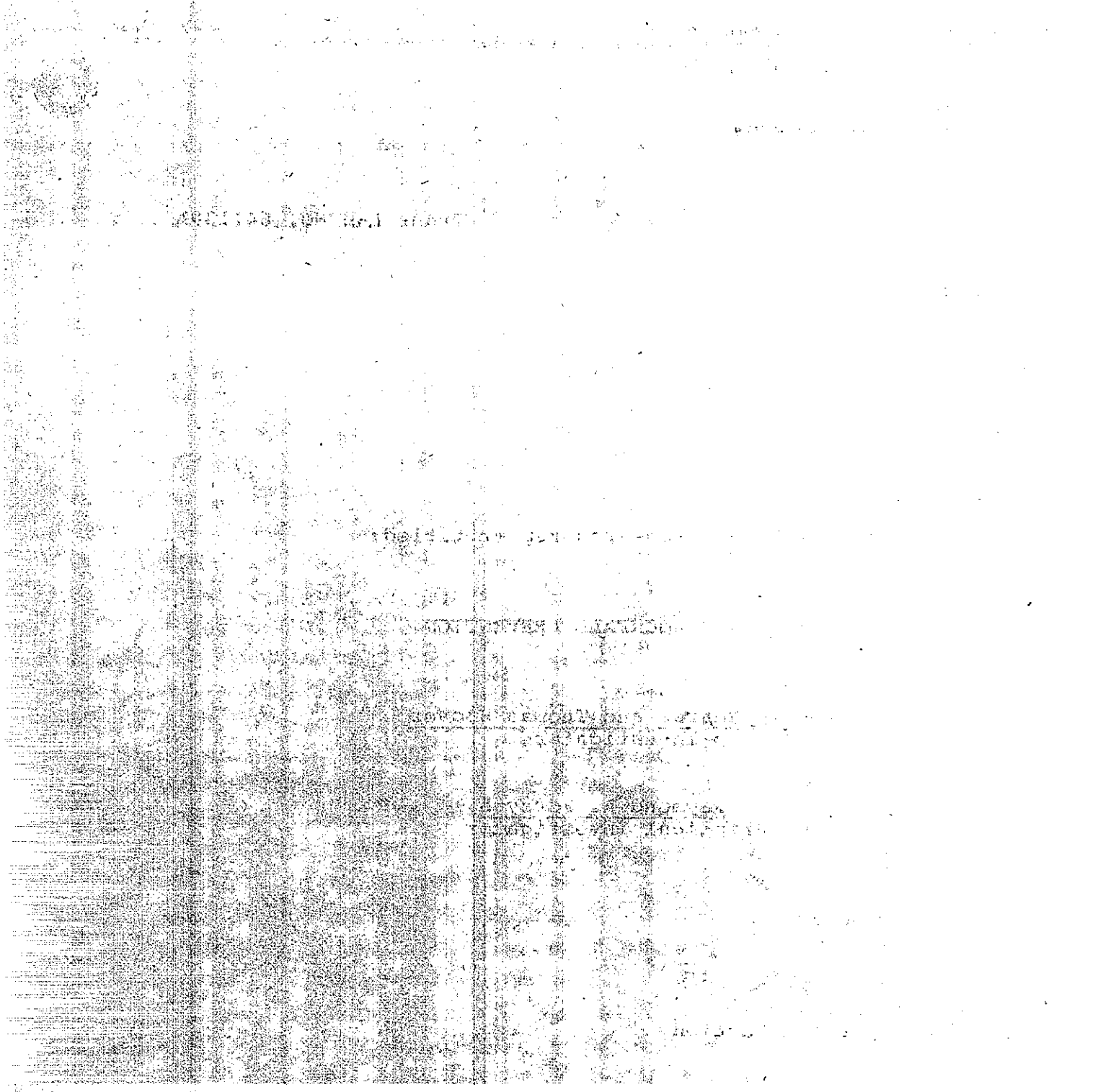
Raymond A. Forsyth
Principal Investigator

Very truly yours,


Raymond A. Forsyth
Chief, Foundation Section

A P P R O V E D


JOHN L. BEATON 9/21/73
Laboratory Director



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"The contents of this report reflect the views of the Transportation Laboratory which is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California. This report does not constitute a standard, specification, or regulation."

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REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE

FOR THE YEAR 1881

IN RESPONSE TO A RESOLUTION OF THE HOUSE OF COMMONS

PASSED ON THE 12TH MARCH 1881

BY THE COMMISSIONER OF THE GENERAL LAND OFFICE

AND BY THE SECRETARY OF THE LAND OFFICE

THE LAND OFFICE, LONDON

PRINTED BY THE STATIONER GENERAL

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INTRODUCTION

Many areas of California contain cuts in uncemented or poorly cemented granular material. Weathering, gravity and erosion transport much of this material onto the roadway. The sizes of these transported particles range from a few microns to a few yards.

In this project it was intended to control this process by binding the small particles together which in turn support the larger ones. Such a binding of particles could help prevent rocks and mud from reaching the roadway. Improved traffic safety and decreased maintenance costs would result.

The testing was performed on two products at two locations. The products used were Soil-Lok and Soil-Bond HP401 (See appendix for material descriptions). The locations were in El Dorado County on Highway 89 at postmile 4 near Luther Pass (Plate 1) and at postmile 16.44 near Emerald Bay. (Plate 2)

CONCLUSIONS

The Soil-Lok and Soil-Bond treatments did cement the smaller particles together thus decreasing erosion, ravelling and rockfall. (Plates 3 and 4). The treatment near Luther Pass resulted in a savings of at least 10 man days, plus equipment, from that required for cleanup prior to treatment. This amounts to approximately \$1,500, while the cost of treatment with Soil-Lok was about \$2,600. Treating this area entirely with Soil-Bond would have only cost about \$500. Any further treatment should be with Soil-Bond at the rate of 400 gals/A. This would result in a net savings of approximately \$1,000 over that spent by not treating this area. It also increases the safety to the traveling public and prevents unsightly gutter rubble.

The treatment at Emerald Bay was not as effective in preventing erosion and ravelling because the treatment didn't extend to the top of the slope (Plate 5) and because of man-caused degradation. The surfaces still intact are approximately equivalent. Any further testing should probably be done with Soil-Bond. It appears to be as effective as Soil-Lok and is more economical.

RECOMMENDATIONS

It is recommended that no further testing of Soil-Lok be undertaken at this time. The expense of treatment appears to be too great in relation to the benefits derived.

It is recommended that certain slopes be treated with Soil-Bond at a rate of 400 gallons per acre. The slopes should have serious ravelling and rockfall problems and should have clearly identifiable maintenance costs and accident records. These treatments should be done in lieu of regular maintenance work and should be carefully monitored to determine performance and effective life.

PROCEDURE AND RESULTS

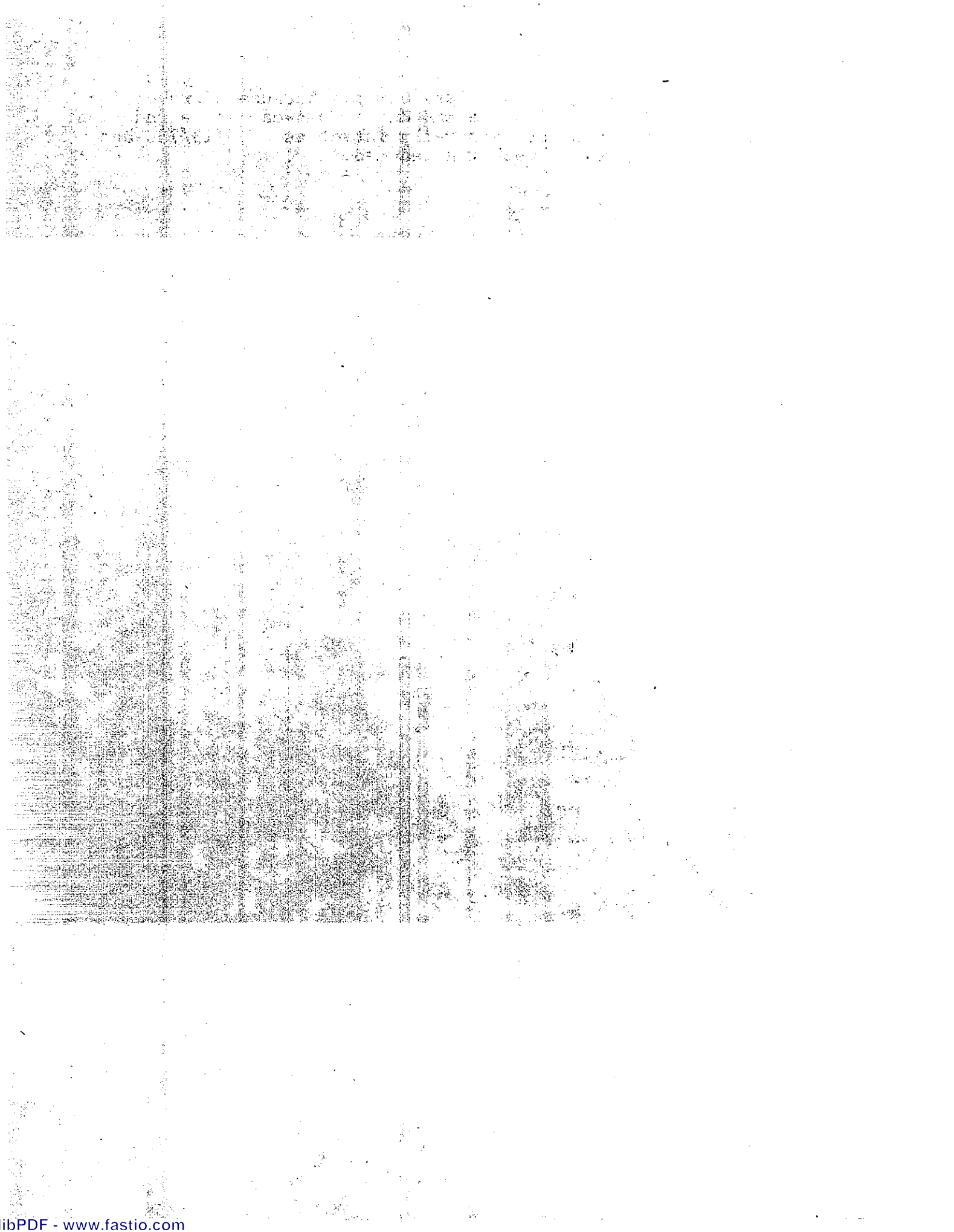
On May 31 and June 1, 1972, after the slopes and gutters had been cleaned at Luther Pass, the slopes were treated with Soil-Lok and Soil-Bond. The Emerald Bay area slopes were also treated at this time. See figure 1 for slope descriptions. The treated area at Luther Pass is of fractured granitic rocks overlain by moraine, (Plate 6) while that near Emerald Bay is granitic rock that has disintegrated in varying degrees. (Plate 7) The cost of treating both areas with Soil-Lok (31,190 sq. ft.) was approximately \$4,600. The Soil-Bond was put in at the distributor's expense as a test from which mutual benefit might be derived. The Soil-Lok application was in two stages: first, the slope was sprayed with sodium silicate then with calcium chloride. The application appeared to be 3/8" thick when applied in the loose D.G. It is difficult to say how deeply it penetrated into the solid D.G. but it seemed to be well absorbed even when the surface was vertical. The runoff was generally minimal, but where there was runoff due to saturation having been reached with the silicate material, the calcium chloride solution runoff and the result was a thin curled crust of CaCO_3 over the silicate saturated soil.

The application process was tedious, due to ordinary garden hoses being used both to apply the silicate and the calcium chloride and to fill the truck tanks. (Plate 8). The Soil-Lok rates of application were: at Luther Pass 4270 gals. of combined chemicals /A (3 sodium silicate to 1 calcium chloride) and Emerald Bay 5186 gals. of chemicals /A.

The Soil-Bond was diluted 5:1 with water then applied by garden hose. The application rates were Luther Pass (350 gals. of Soil-Bond) /A and Emerald Bay 390 gals/A. The Soil-Bond was easier to apply as it was only one step. It offered a better cementing action where runoff occurred.

At Luther Pass the success of the treatment permitted removal of the rock fence and kept debris off the travelled way (Plate 9). The maintenance crew in this area estimated a savings of at least 10 man days not required for rock cleanup. They had no emergency call backs for rock removal. Some degradation of the surfaces had begun by 7/13/73. (Plate 10).

The results at Emerald Bay are less obvious because of ravelling from the untreated top of slope and due to man-caused degradation. The surfaces were, however, generally intact as of 7/13/73, and the quantity of ravelled rock was reduced.

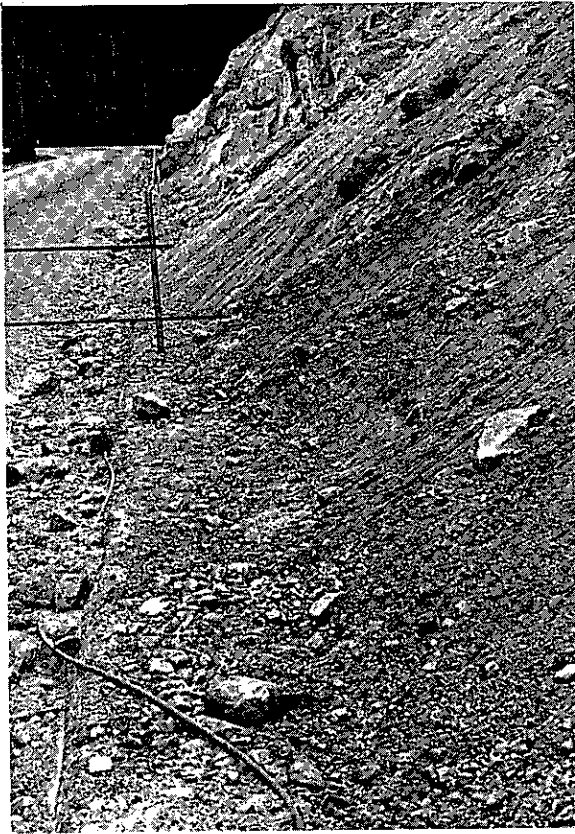




Center of Luther Pass cut
Plate 1



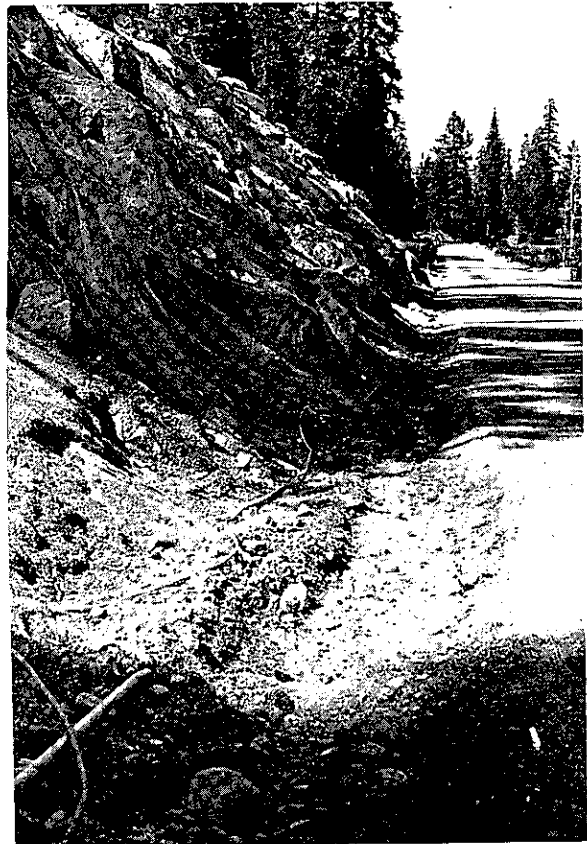
Center of Emerald Bay cut
Plate 2

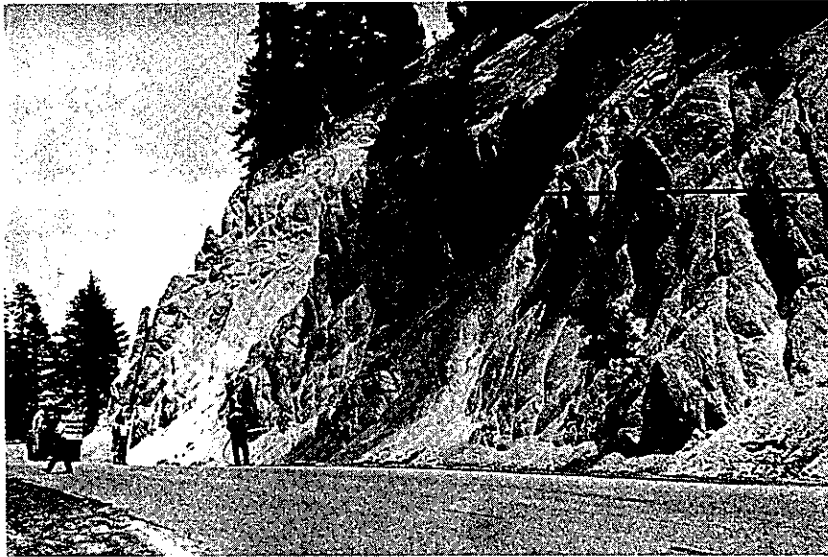


untreated area between lines

Shoulder looking South at
Luther Pass after 4 months
Plate 3

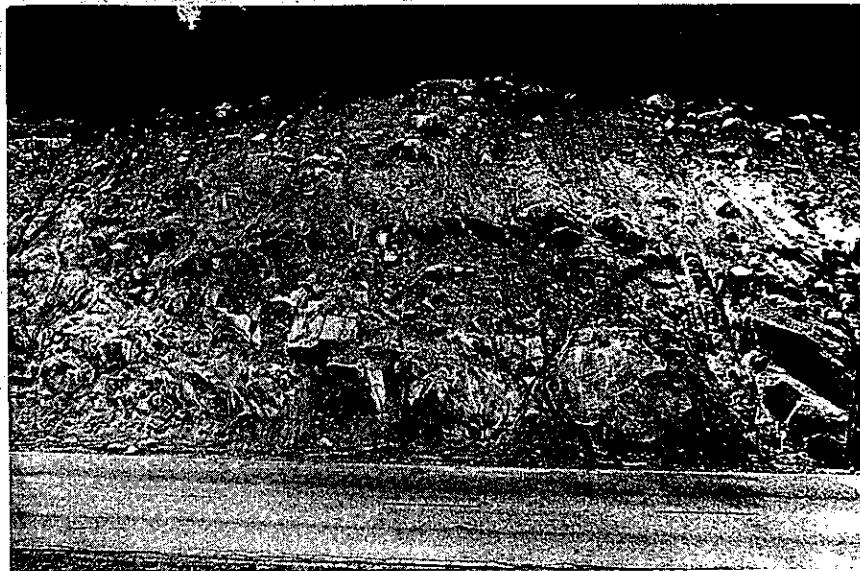
Shoulder looking North at
Luther Pass after 4 months
Plate 4



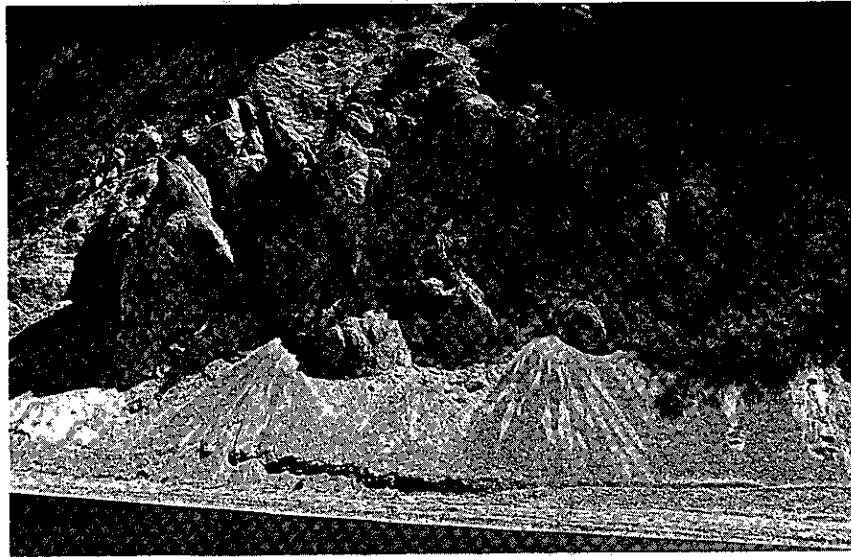


Approximate height
of treatment

Emerald Bay Treatment
Plate 5



Luther Pass Slope Materials
Plate 6



Emerald Bay Slope Material
Plate 7



Applying Soil-Lok
Plate 8



Gutter 11 months after treatment
Plate 9



Beginning rockfall as of 7/13/73
Plate 10

Appendix

Soil-Bond HP401 copolymer solution

Physical Properties

| | |
|----------------|--|
| Color | White |
| Weight/gal | 9.1 lbs. |
| Percent solids | 55±1 |
| pH | 2-4½ |
| Viscosity cps* | 800-1500 |
| Film | colorless, transparent, non-reemulsifiable |
| Shelf life | 1 yr.+ |

* Model RVT, Spindle No. 2 @ 2000 RPM, 73°F

Soil-Lok a two solution reaction treatment

Solution 1 is a sodium silicate base containing additives to improve penetration.

Solution 2 is a calcium chloride solution which reacts with solution 1 to create a watertight insoluble matrix that bonds together the soil particles.

